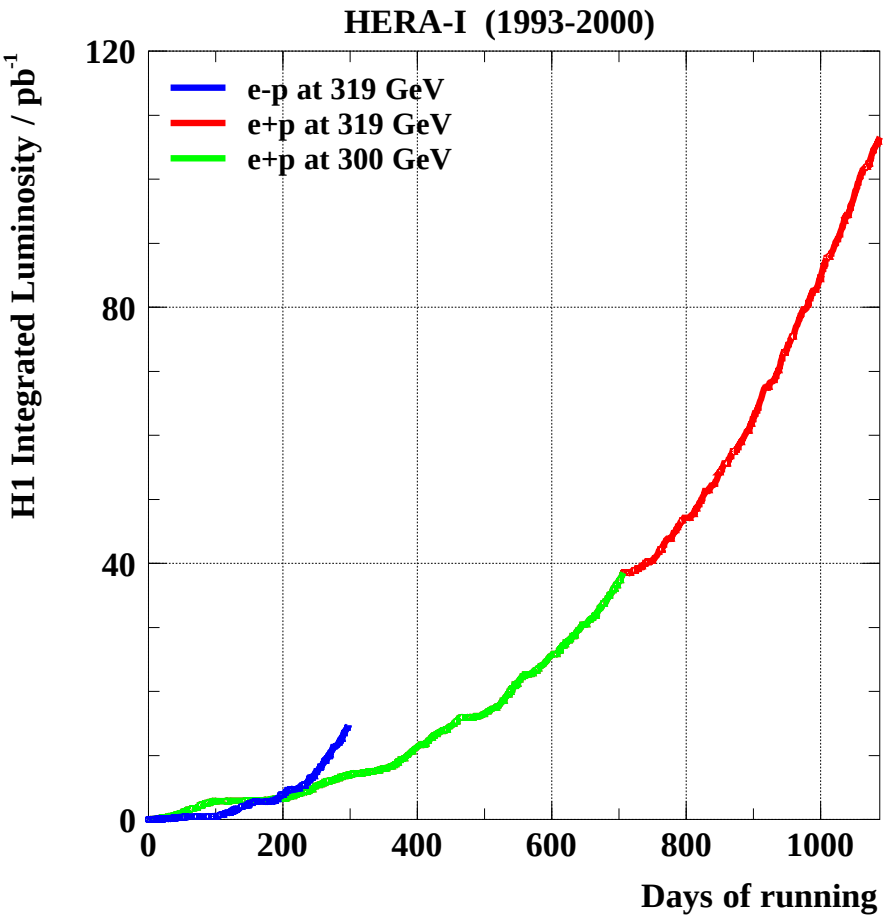
H1 Status Report, October 2000

Paul Newman, Birmingham University

- Pre Upgrade Data Collected
- Ugrade Status
- Recent Physics Results
- QCD Physics Before and After the Upgrade

Final HERA-1 Samples



Bulk HERA-1 Data samples

e^+p: $107\,\mathrm{pb}^{-1}$

e^-p: $15\,\mathrm{pb}^{-1}$

Special samples for low Q^2 / transition to photoproduction

Minimum bias triggers 97/9: $6.9\,\mathrm{pb}^{-1}$

Shifted vertex 2000: $0.7\,\mathrm{pb}^{-1}$

Status of H1 Upgrade Projects

Many Upgrade projects to be completed for startup of HERA-2

BeAl beampipe
Central Silicon
Backward Silicon
Forward Tracker
Backward ‘SPACAL’ calorimeter
Calorimeter ‘Jet’ Trigger
Luminosity System
Level 4 / 5 Filters

Superconducting Magnets
Forward Silicon
Central MWPCs
Backward MWPCs
Calorimeter Data Acquisition
Time of Flight Devices
Forward Neutron Calorimeter

No delays to overall H1 schedule.

Superconducting magnets (Brookhaven) needed in H1 04/01

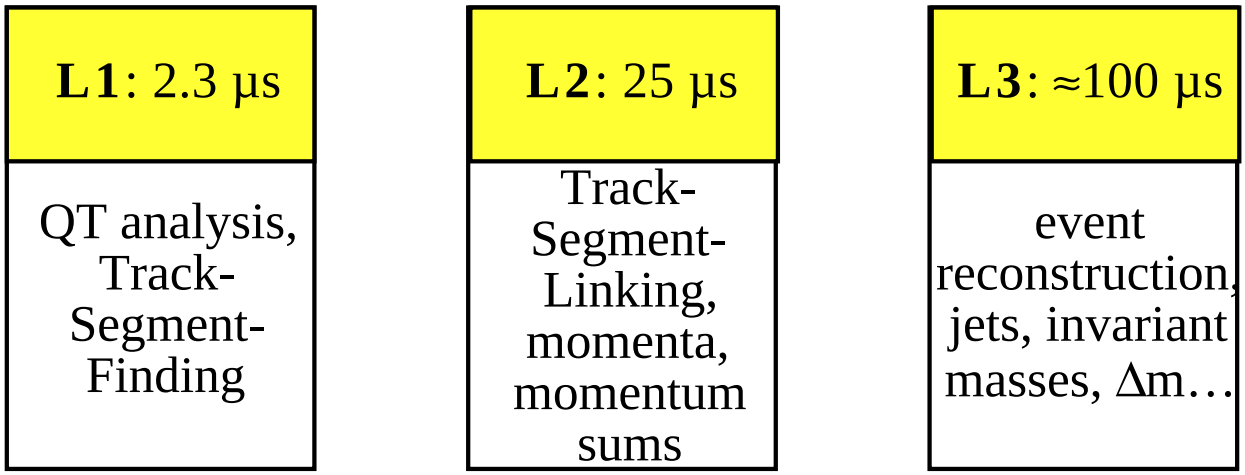
Additional projects not tied to 9 month shutdown

Fast Track Trigger
Very Forward Proton Spectrometer

To be discussed in closed session

Fast Track Trigger

Trigger signals derived from selected Central Jet Chamber wires . . .



- Improved track p_T thresholding / multiplicity counting / topology searches at L1-3.
- Resonance searches at L2-3 (D^*, vector mesons) . . .
- Option to send information to L1 trigger now incorporated

  Will allow lower, more precise threholds for e.g. ρ, ϕ

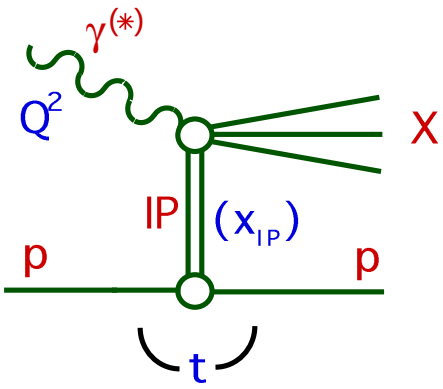
  Synthesis of L1 algorithms to FPGAs well advanced

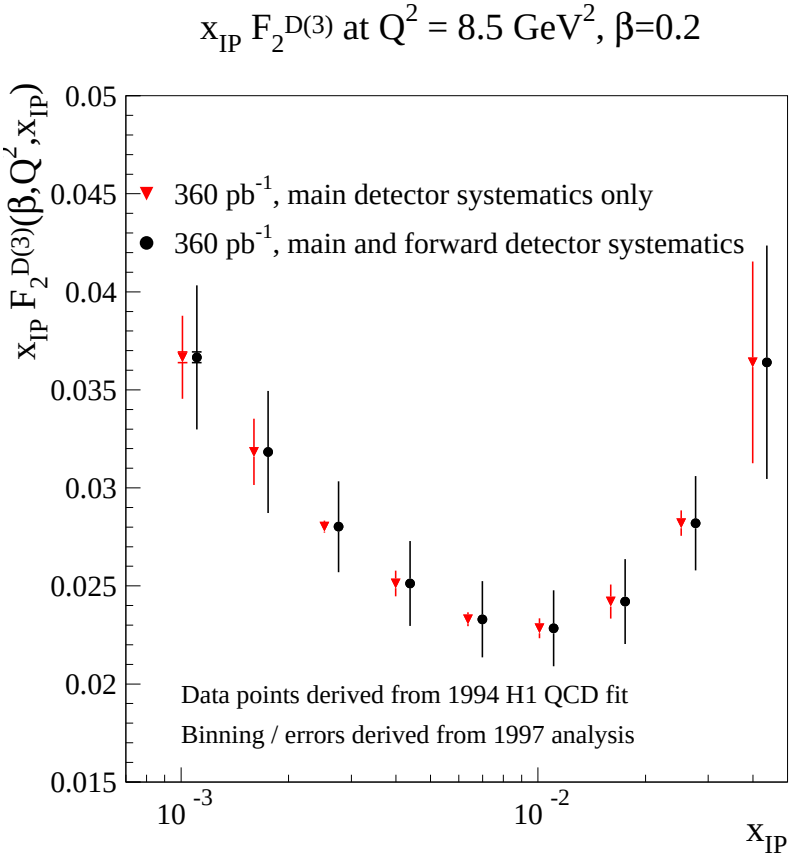
  L1 Hardware specification nearing completion

Very Forward Proton Spectrometer

Roman pots in the region of $z = 200$ m . . .

- High acceptance allowing precision studies of $ep \to eXp$





- Large reductions in systematics relative to present 'rapidity gap' selection.

- Collect high statistics for rare channels . . . diffractive jets, charm, vector mesons at high Q^2 . . .

- Measurements of t dependences.

H1 Publication Status

H1 has now published 90 papers in refereed journals.

35 Papers were submitted to ICHEP2000 . . .

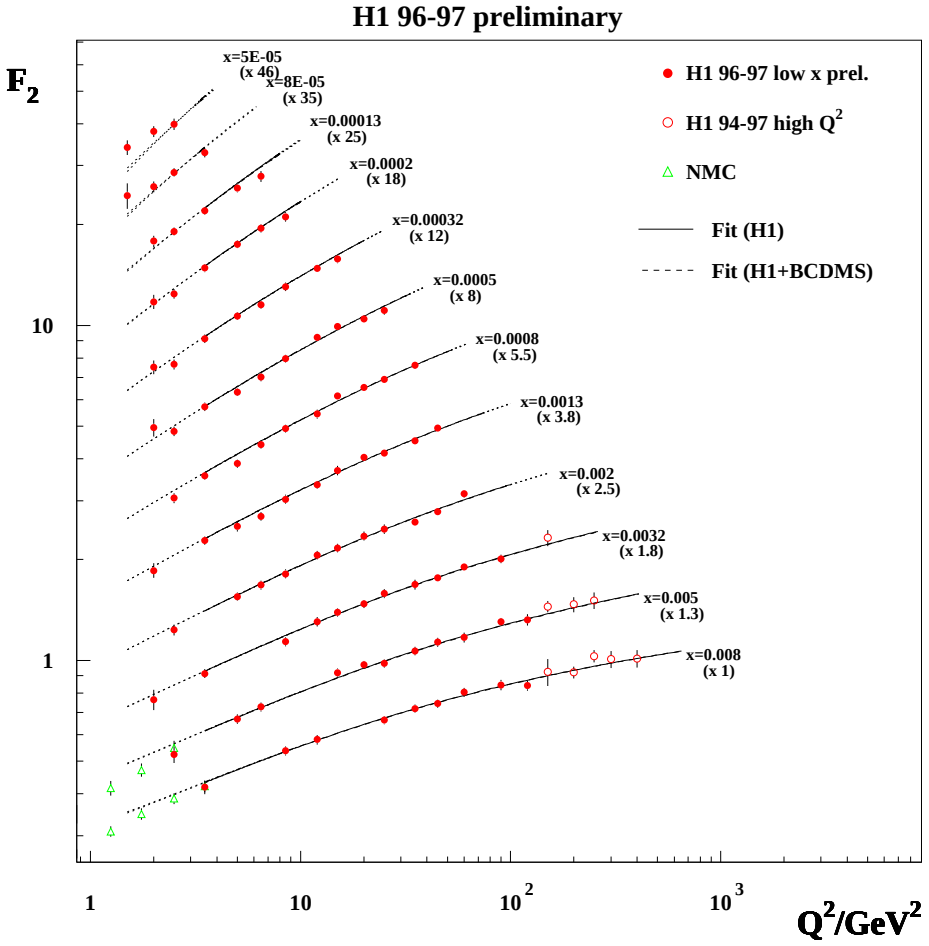
. . . of which, 27 were based on newly released results.

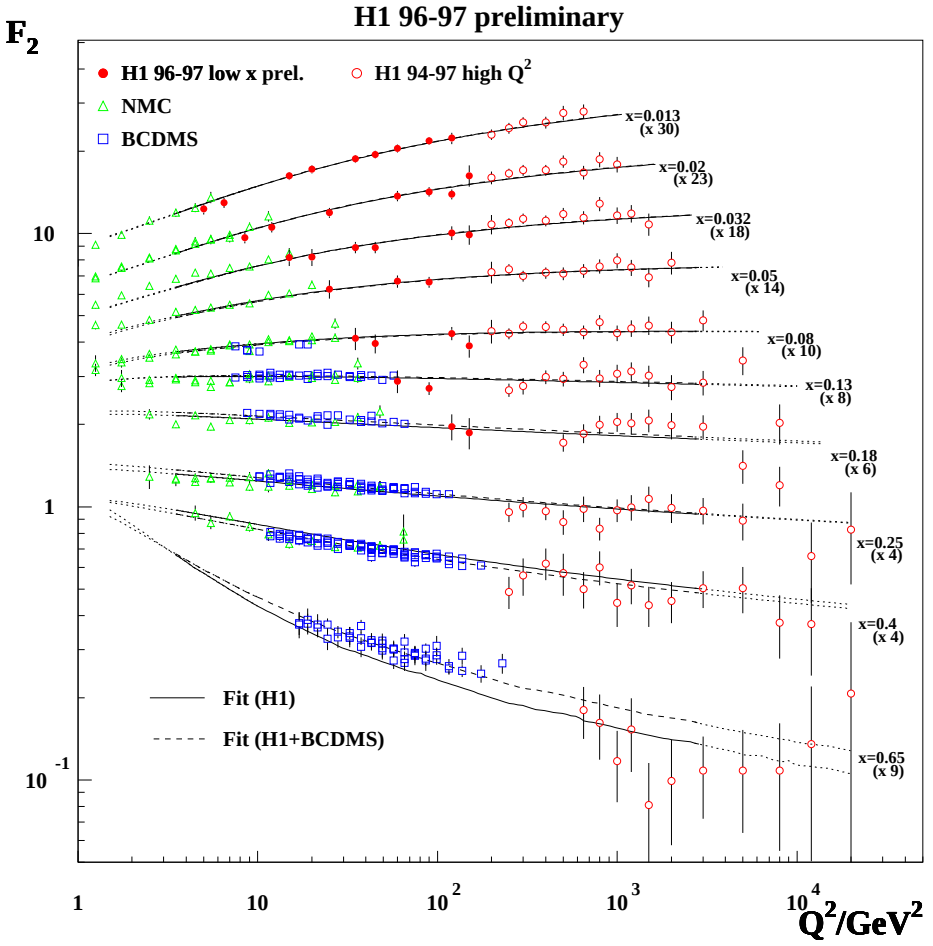
Some Selected Highlights not Covered here . . .

- Competitive limits on leptoquarks, $\not{R}_p$ -SUSY, l^*, contact int$^{\mathrm{n}}$s, large extra dimensions from almost all HERA-1 data.
- e^+p, e^-p CC & NC Cross Sections from almost all HERA-1 data.
- First measurement of $xF_3(x,Q^2)$ - $\gamma^* Z$ interference
- $xu_v(x,Q^2)$, $xd_v(x,Q^2)$ from high x CC data.
- Differential Dijet Cross Sections at High Q^2 in both CC and NC.
- b Cross sections from decay lengths in silicon.

Focus of this talk is on the development of our understanding of QCD.

Precision F_2 Data





F_2 measured in huge phase space.

$< 1\%$ (stat) $\oplus$ 3% (syst) precision in some regions.

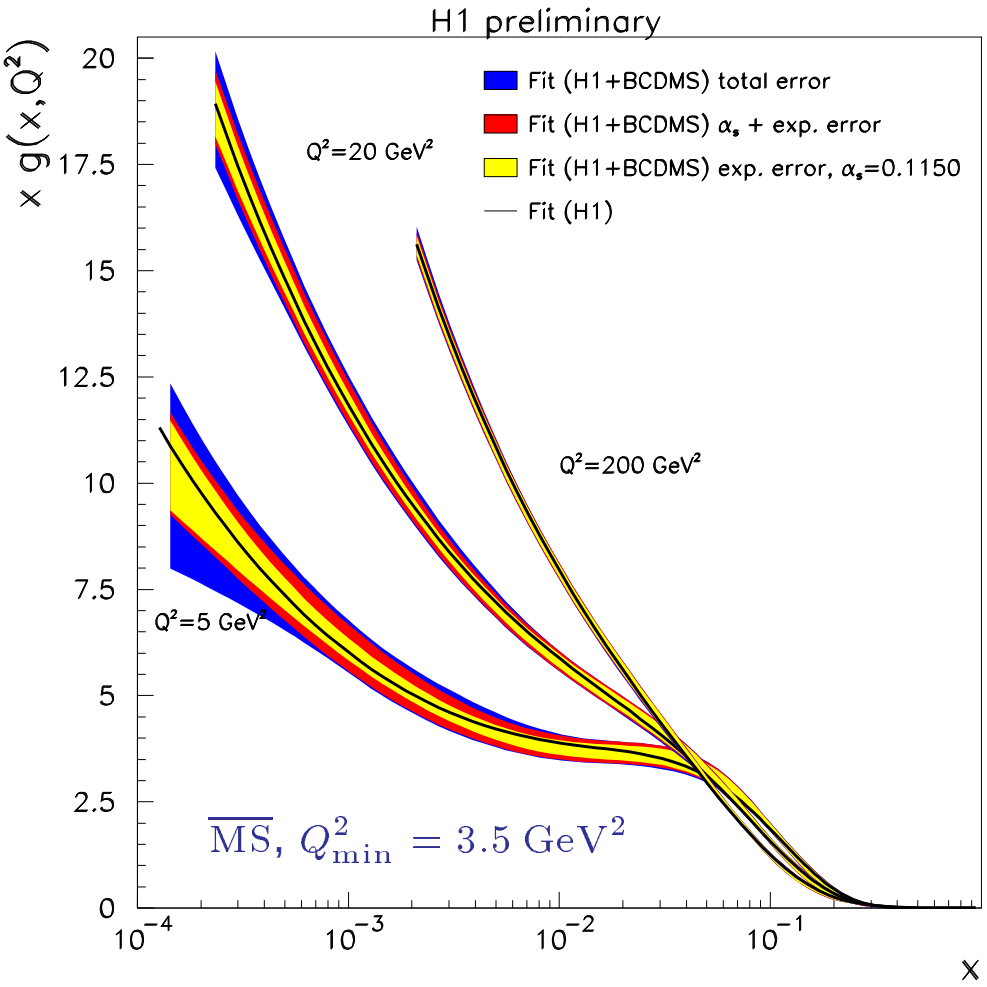
Data remain statistically limited for $Q^2 \gtrsim 2000\,\mathrm{GeV}^2$

Gluon and α_s from Inclusive Data

Simultaneous extraction of α_s and $xg(x, Q^2)$

NLO DGLAP analysis of H1 data with $1.5 \leq Q^2 \leq 3000\ \mathrm{GeV}^2$ (1994-7) and BCDMS high x data.

Full correlated error treatment.

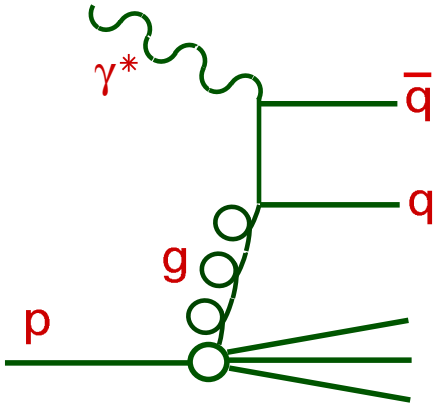


$$\alpha_s(M_Z^2) = 0.1150 \pm 0.0017\,(\mathrm{exp.})\ ^{+0.0011}_{-0.0012}\,(\mathrm{model})$$

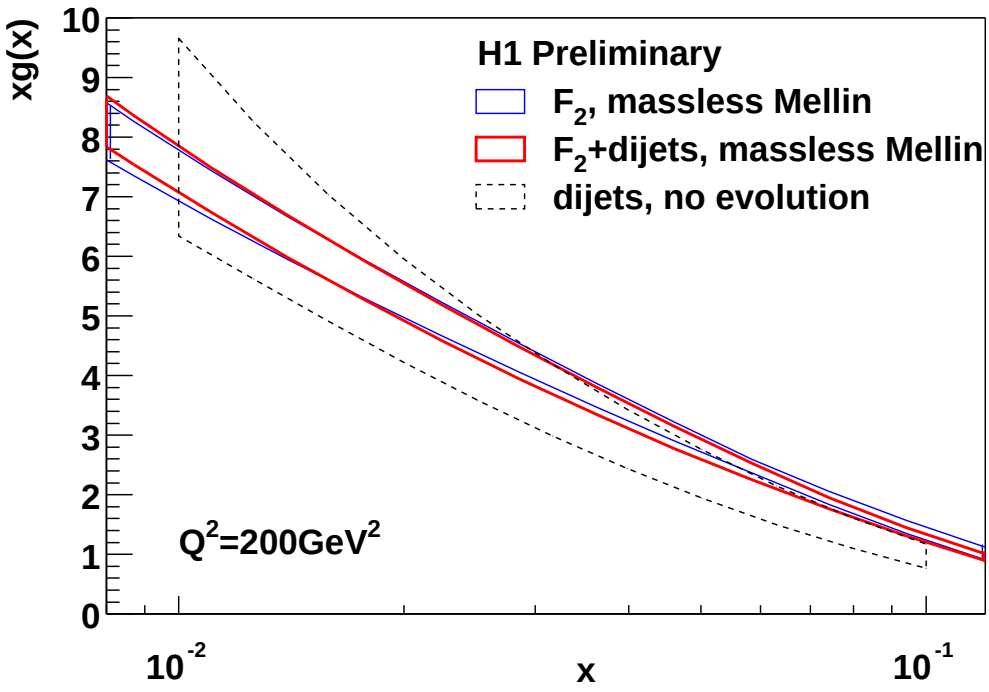
Additional uncertainty ~ 0.005 (renormalisation & factorisation scales) - will decrease when NNLO formulae available.

QCD Tests in the Final State

Final states containing charm or dijets are sensitive to $xg(x, Q^2)$ and α_s through Boson Gluon Fusion.



- Consistency checks with extractions from DGLAP fits.
- Tests of QCD Factorisation Theorem.



Based on H1 F_2 and jet data '95-7

Consistency between combined fit, F_2 only and dijets only.

Similar extraction from charm extends to lower x.

Improved statistics required for detailed tests of theory.

Charm and Low x Dynamics

D^* Cross Sections measured in Visible Kinematic Range.

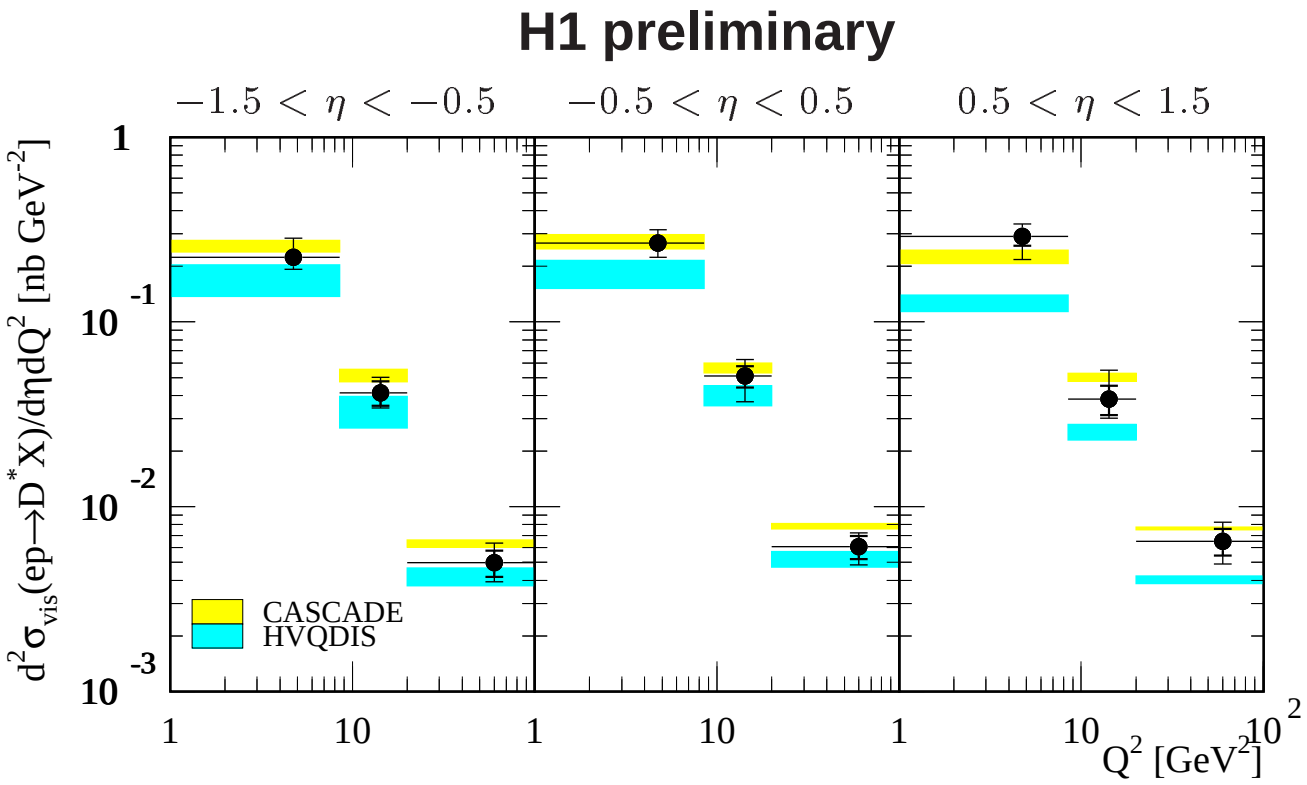
'HVQDIS' MC generator (NLO DGLAP, charm through BGF)

'CASCADE' MC generator (CCFM evolution)

CCFM imposes angular ordering on emissions.

$\rightarrow$ DGLAP at large x, $\rightarrow$ BFKL at low x.

Simultaneously describes F_2, 'forward' jets, Tevatron J/ψ.

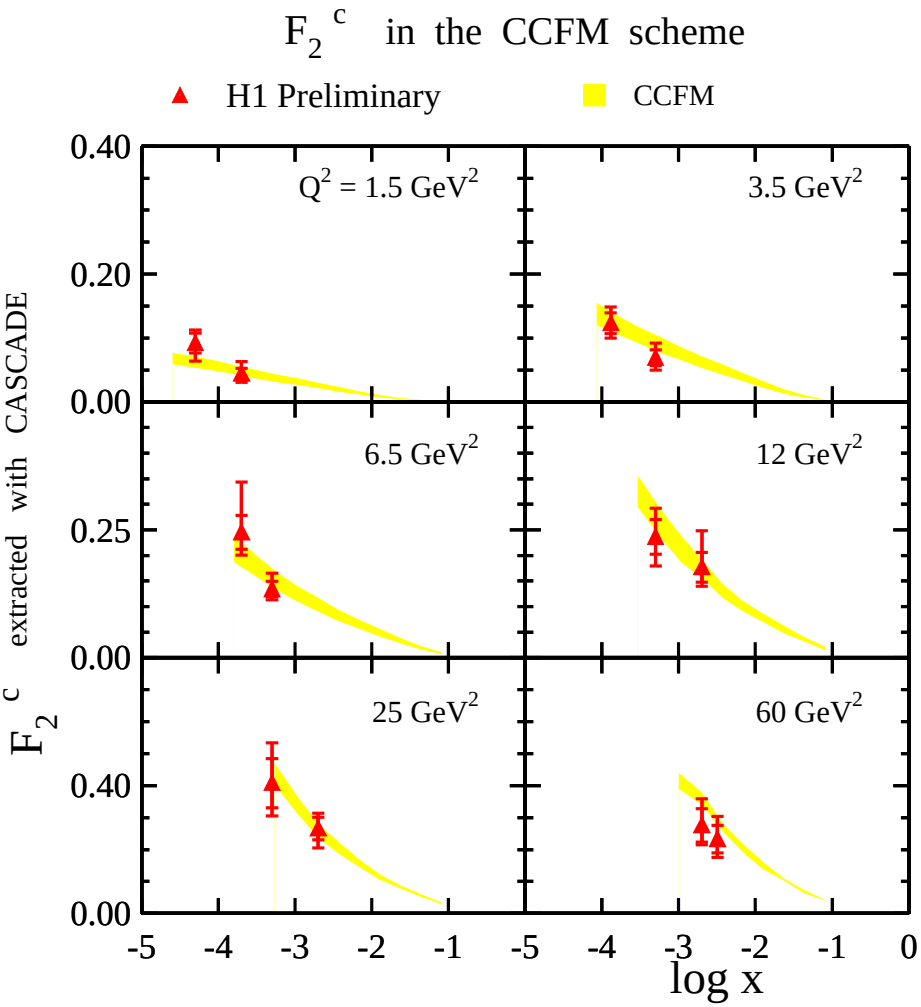


Basic consistency with QCD predicitons.

CCFM gives best description in forward region, low p_T

Charm Structure Function

Extrapolate $\sigma(D^*)$ to full phase space to extract $F_2^c(x, Q^2)$.



Shaded bands show uncertainty from m_c

Scheme dependence uncertainty not shown.

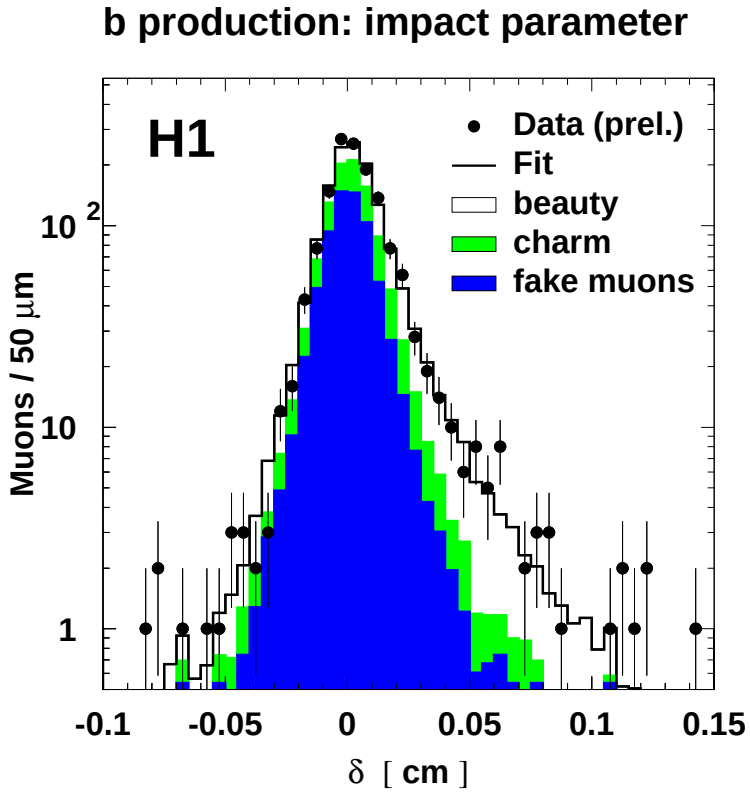
Increasingly precise data with improving power to discriminate between models

Track trigger upgrade will allow large charm samples to be collected at HERA-2.

Silicon microvertex detectors will improve analysis and allow extentions to lower and higher x.

Beauty Cross Section from Silicon

Photoproduction b cross section successfully extracted using central silicon microvertex detector



From CST measurement alone . . .

$$\sigma_{\rm vis}(ep \to b\bar{b}X \to \mu X') = 159 \pm 30(\text{stat.}) \pm 29(\text{syst.})\ \text{pb}$$

Combining with relative p_T in $\mu + \text{jet}$

$$\sigma_{\rm vis}(ep \to b\bar{b}X \to \mu X') = 160 \pm 16(\text{stat.}) \pm 29(\text{syst.})\ \text{pb}$$

Consistent with previous result from $\mu + \text{jet}$.

Significantly larger than NLO QCD prediction

$$\sigma_{\rm vis}(ep \to b\bar{b}X \to \mu X') = 104 \pm 17\ \text{pb}$$

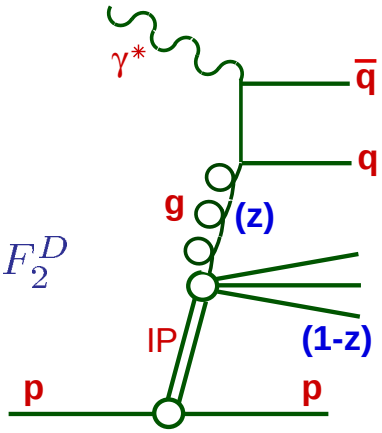
Diffractive Dijet Electroproduction

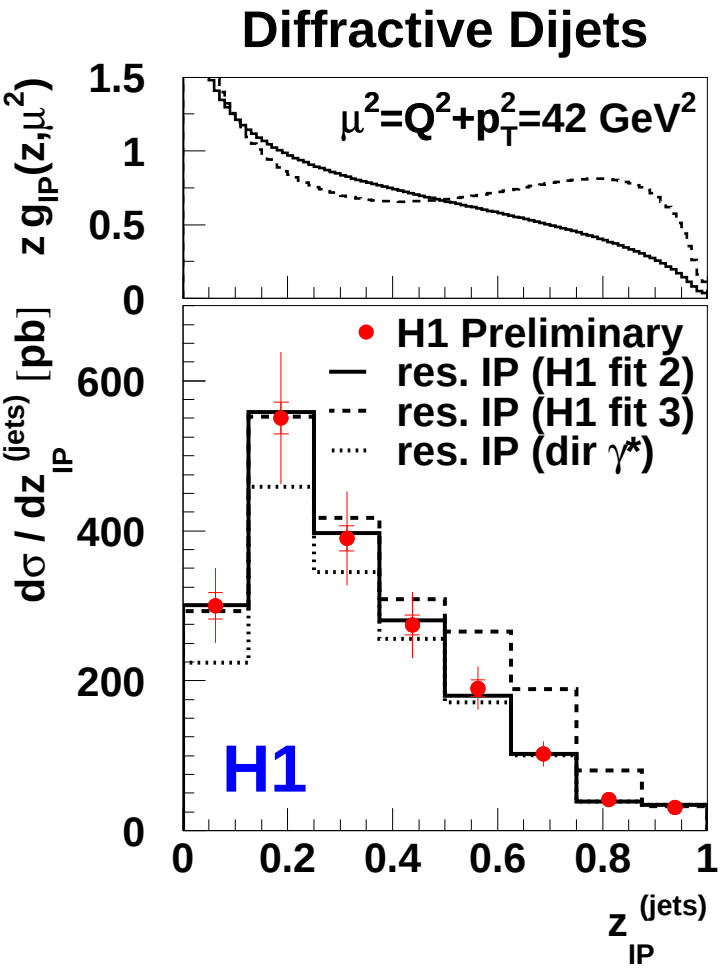
Pushing back the boundaries of QCD . . .

Study dijets as components of X in $ep \to eXp$.

Highly competitive direct sensitivity to gluon distribution of $\mathbb{P}$ (via BGF)

Test recently proven QCD fac'n theorem for diffractive DIS by comparing with partons from F_2^D





The best constraints on diffractive gluon so far.

Remarkably good agreement with F_2^D based predictions (H1 fit 2, H1 fit 3).

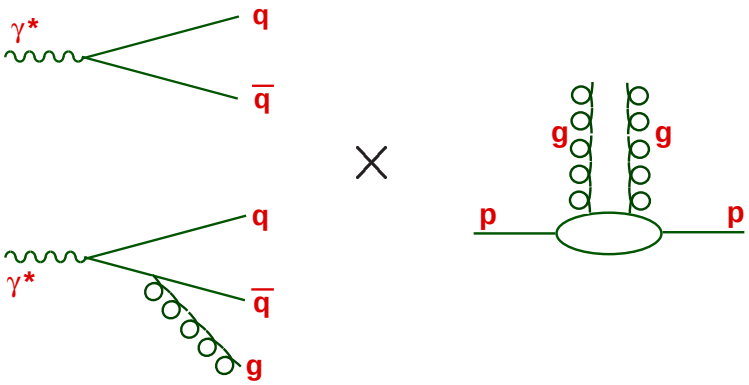
'Flat' gluon distribution of $\mathbb{P}$ (fit 2) preferred.

Diffractive Dijet Electroproduction

QCD models developing largely via p-rest frame picture.

$\gamma^* \rightarrow q\bar{q}, q\bar{q}g$ well in advance of target . . .

Partonic fluctuations scatter ‘elastically’ from proton.



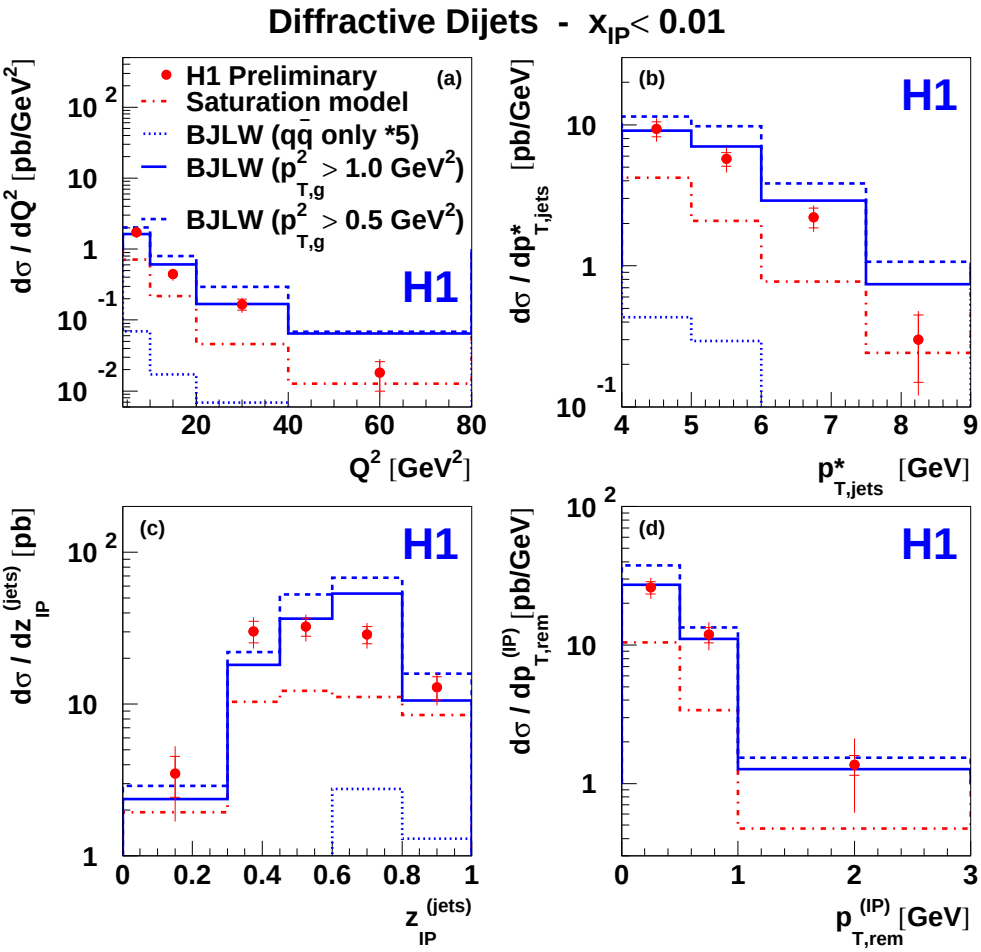
‘Saturation’ & ‘BJLW’ models based on exchange of two gluons with cancelling colour charge.

Shapes at low $x_{I\!P}$. can be reproduced

Normalisations need tuning (t dependence?)

VFPS will allow improved precision for HERA-2.

Towards a complete partonic description . . .



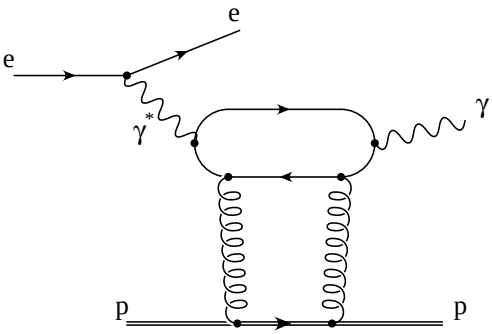
Deeply Virtual Compton Scattering

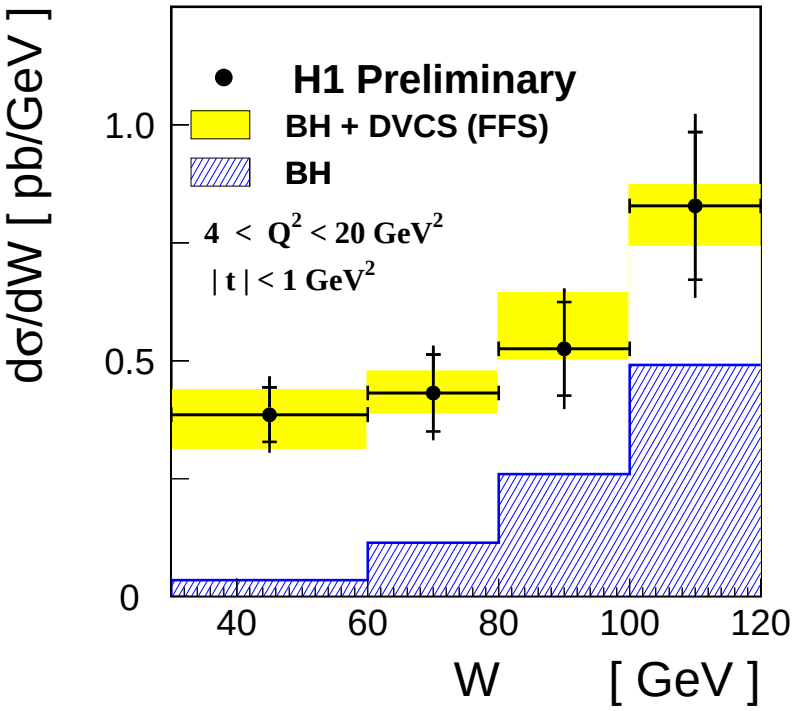
Another probe of 2-gluon exchange . . .

'Diffractive' $ep \to e\gamma p$

Promising process for access to 'skewed' parton distributions.

Background and interference from Bethe-Heitler process.





Excellent agreement with calculations.

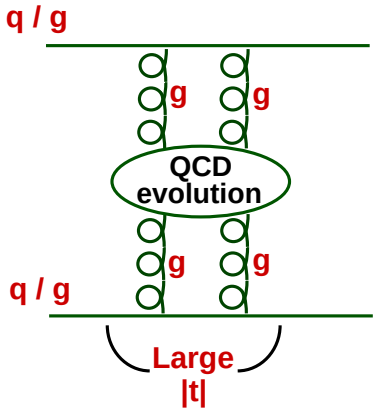
Largest theoretical uncertainties from t dependence (bands).

VFPS will give high acceptance at low W.

Rapidity Gaps between Jets at $Q^2 = 0$

Parton level

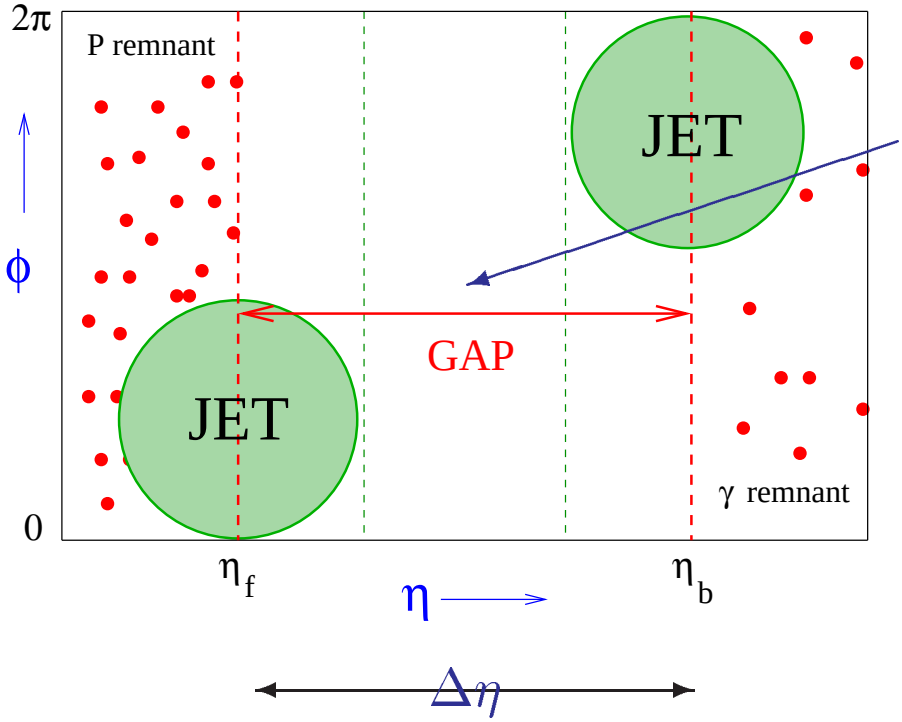
Elastic parton-parton scattering
in Regge limit ($\hat{s} \gg \hat{t}$), yet
pQCD calculable ($\hat{t}$ large)? . . . BFKL?



Hadron level Classic experimental signature is rapidity gap between high p_T jets. $|\hat{t}| \sim p^2_{t,jet}$

Complication: Remnant-remnant interactions produce hadronic activity between jets?

New Measurement Method:



$\not{E}_t^{jets} = \sum E_t$
for $\eta_f > \eta > \eta_b$.
outside two leading jets

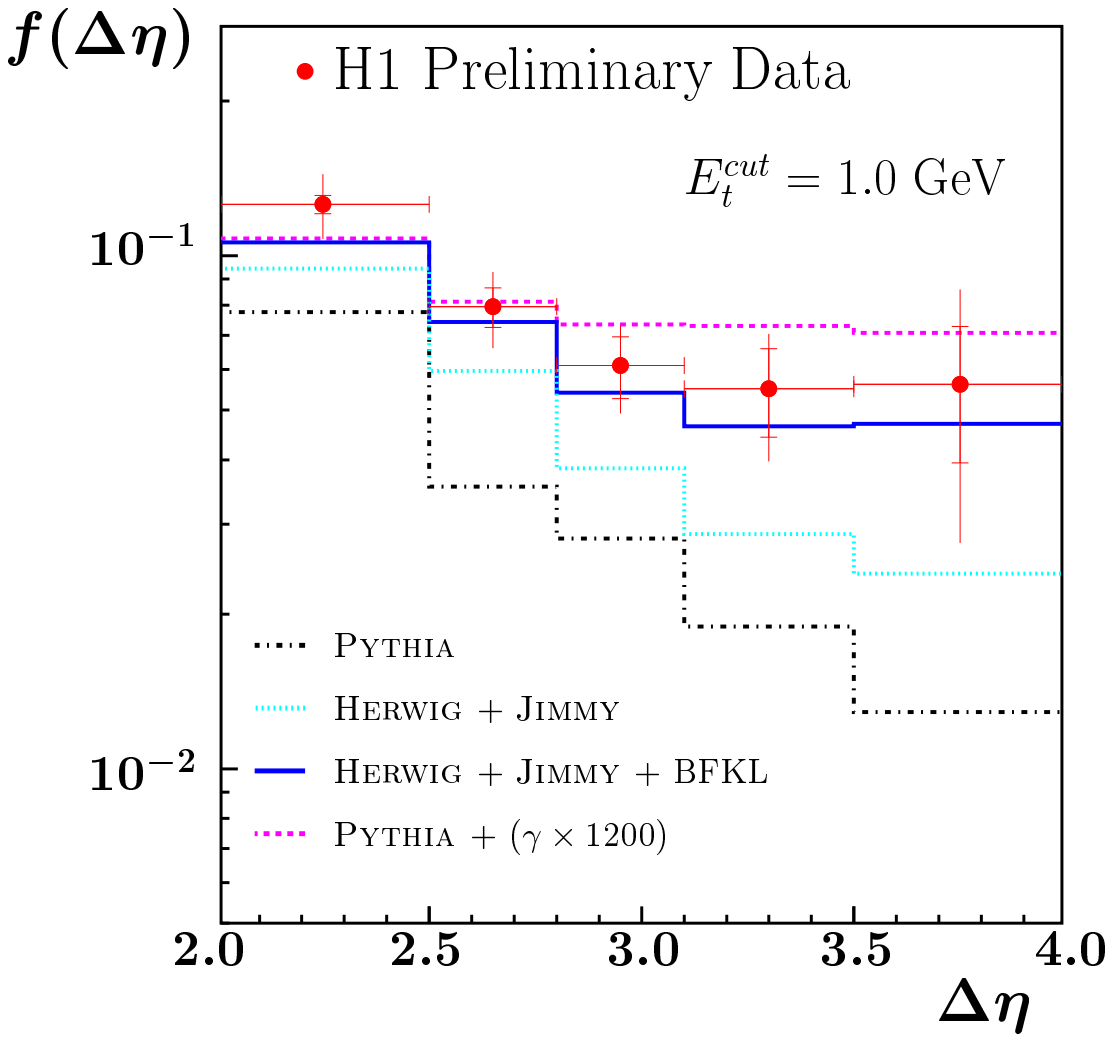
Rapidity gap event if
$\not{E}_t^{jets} < E_t^{cut}$

Vary E_t^{cut} to study effect of spectator interactions.

Dependence of Gap Fraction on $\Delta\eta$

Dependence on jet separation $\Delta\eta$ particularly sensitive to dynamics.

Measured for various E_t^{cut}, 1 GeV chosen here.



Clear signal above standard γp models, increases with $\Delta\eta$

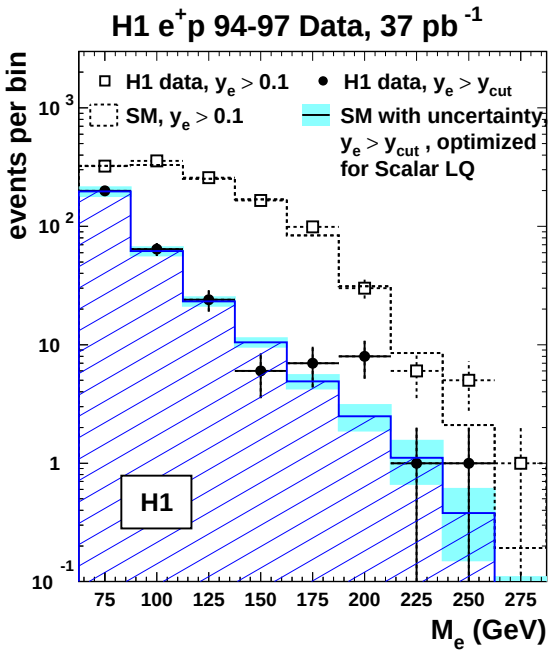
Gap fraction at large $\Delta\eta$ significantly larger than Tevatron $p\bar{p}$.

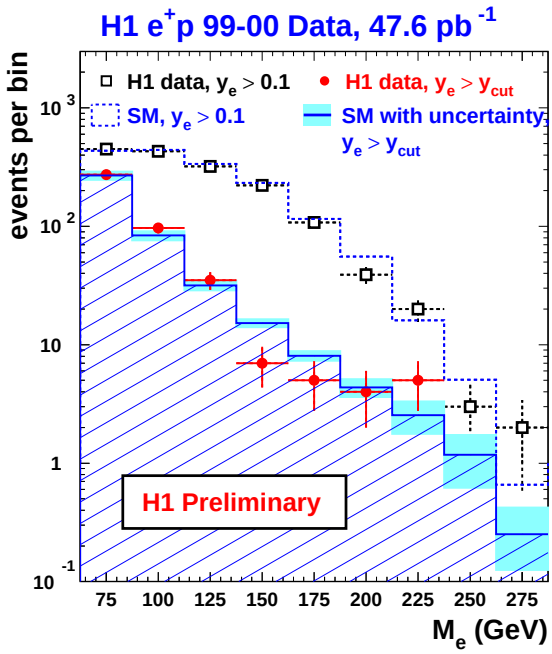
Calculation based on BFKL pomeron can describe data.

Leptoquark Search

High Q^2 excess reported in 1994-6 data, around $M = \sqrt{xs} = M_{e+\mathrm{jet}} \sim 200\ \mathrm{GeV}$, most significant at high y

Signal became less significant with addition of 1997 data.



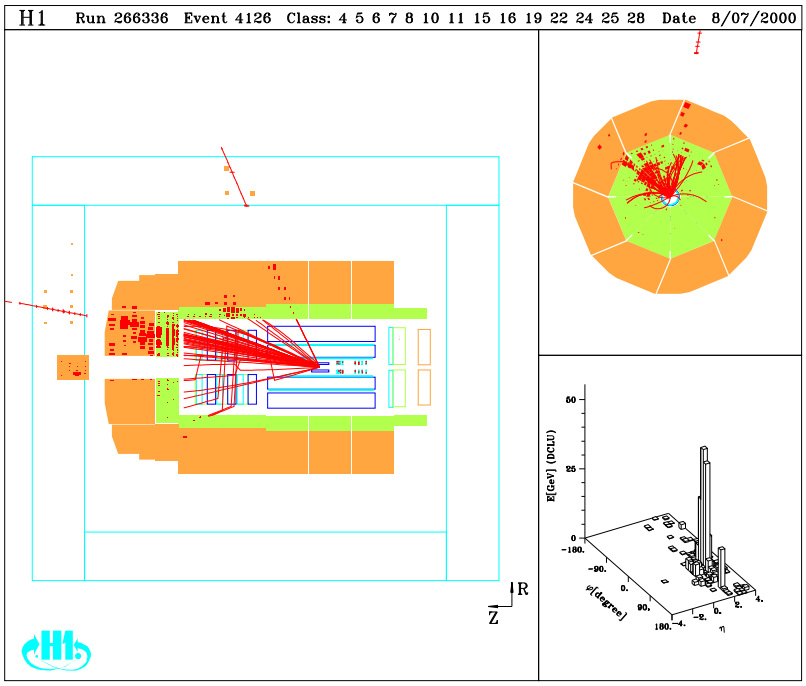


No excess visible in 1999-2000 e^+p data.

Earlier signal attributed to statistical fluctuation.

Derive limits instead

A process to watch closely at HERA-2



- In e^+p, isolated leptons with missing p_T (W signature) still appear faster than expected at high p_T of hadronic recoil.

H1 94-00 e^+p 82 pb^{-1} Preliminary	H1 Prelim Data $(e+\mu)$	Standard Model Expectation
$P_T^X > 0$ GeV	14	8.16 ± 1.97
$P_T^X > 12$ GeV	12	4.07 ± 1.03
$P_T^X > 25$ GeV	9	2.26 ± 0.57
$P_T^X > 40$ GeV	6	0.79 ± 0.22

No events found in 13.6 pb^{-1} of e^-p data.

Upgraded track trigger will improve W analysis at HERA-2.

Summary

- H1 successfully ran through HERA-1
  - Many significant contributions made
  - Lots more results expected in near future
- H1 currently on schedule for HERA-2
  - Exciting upgrade projects
  - Looking forward to high precision at high Q^2 and p_T
  - Final state measurements at low x require much more data to really develop understanding of QCD
  - Upgrade projects crucial!